Limiting local pressure in post-compensated valves

(Source: Bucher Hydraulics)

Bucher Hydraulics has found a way to combine the advantages of pre-compensated load sensing (LS) valves with those of post-compensated flow-sharing valves. CAN and J1939 are also part of this.

The HDS24 flow-sharing valve combines the post-compensated function (can continue to work in undersaturation, or under-supply mode) with the LS local pressure limitation, and enables precision movement in a range of applications. Load sensing valves are well known and popular because they are the best way to control actuators independently of the load pressure. The technology behind this kind of directional valve developed over time, creating two families, the pre-compensated and the post-compensated valves.

The pre-compensated valves are the more common load sensing valves, where the compensator works between the pump pressure and the local section pressure. To do this, the compensator is forced to work with a fixed delta P determined by the compensator spring, and the highest section LS pressure feeds the load sensing pump. The main advantage of this solution is, thanks to a small LS relief valve, of independently limiting the maximum pressure on each section, closing the local compensator and preventing the discharge of the full section flow to tank through port relief valves. Post-compensated valves, or flow-sharing valves, are also load sensing valves, but the local compensator works with the pressure signal from the local section and from the highest LS pressure of the whole valve. In this case the compensator works without spring (or with a very weak spring in some cases).

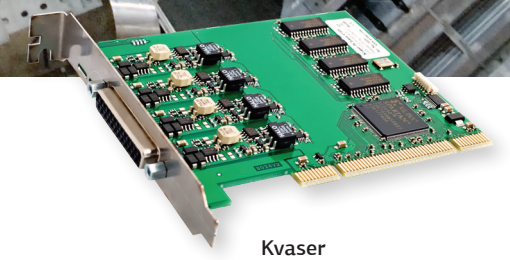
Flow-sharing valves are used in a very large number of applications because the section compensator also can work when the pump cannot supply enough oil (undersaturation). An example is a system with a maximum pump flow of 150 l/min and two simultaneous movements, where the first function needs 80 l/min and the second function 120 l/min (total 200 l/min). In this case, the post-compensated valve is able to work with a smaller delta P on the compensator, and it shares the 150 l/min from the pump to both cylinders in accordance with the following formula:

$$\frac{150}{(120+80)} \times 80 = 60\ l/min$$

to the first cylinder, and 90 l/min to the second.

The proportionality of the two movements (the ratio between the two cylinder speeds) is maintained under all conditions. In the case of a pre-compensated valve, as soon as the system goes into undersaturation the delta P on each compensator drops below the spring force and the compensators open fully, losing any function. In this case, the oil goes to the actuator needing the lowest pressure, just as in a normal open-center directional valve.

CERN's Large Hadron Collider relies on Kvaser PCIcanx boards to connect it's CANopen network.



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The biggest challenge for a post-compensated solution has been how to limit the maximum pressure on each section. The only way to limit the pressure was by using a secondary port relief valve able to discharge the full section flow to tank with a large waste of flow and energy. What Bucher Hydraulics has achieved with the HDS24 flow-sharing valve is the ability to combine the post-compensated function (also able to work in undersaturation) with the LS local pressure limitation. Up to now, this LS local pressure limitation has only been possible with pre-compensated valves. The HDS24 flow-sharing directional valve is available with mechanical, hydraulic, and electro-hydraulic operators as well as the innovative electro-mechanical CAN network pilot system, to give incomparable flexibility, accurate movements, and the new patented solution for the LS section pressure limitation.

Precise movements

The HDS24 flow-sharing directional valve, with spool stroke of 7,5 mm and spool diameter of 16 mm, gives performances in terms of controllability, stability, and responsiveness of the flow control. In combination with the electro-mechanical actuator, the spool hysteresis is reduced to zero. The very fine positioning of loading devices that need slow and parallel movements is therefore no longer a problem when using the device.

The large number of options and variations does not always result in special, customized parts. The sections, end plates, relief, and secondary valves are already used in other Bucher Hydraulics directional valves, thus optimizing the series production, which makes use of assembly solutions and fully automated test benches. The HDS24 is available for LS and fixed-displacement gear pumps, with or without priority valve for steering, main and LS relief valve, and integrated anti-dumping valve used to stabilize the LS signal between the valve and the variable pump. The secondary-port relief valves are available in versions with fixed or adjustable pressure settings. The spools can be piloted by the mechanical joystick, hydraulic, or electro-hydraulic devices.

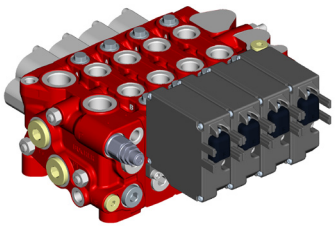

Figure 1: The HDS34 with electromechanical pilot system (Source: Bucher Hydraulics)

Furthermore, the company is now able to offer electro-mechanical operation with stepper motor, without need of any pilot pressure. This solution, after many years of development, is in series production on HDS24 and other Bucher valves.

The main advantages of this solution are the speed of spool movement and accuracy of the spool position. The high spool-movement speed leads to a fast response time, so the end user can see the machine responding as quickly as they are moving the joystick. The stepper motor, responsible for the spool-position accuracy, counts every motor step and thus 'knows' the position of the spool throughout the whole spool stroke. The spool and the electric stepper motor are mechanically connected together, so that the hysteresis is zero. Moreover, by means of a proper interface, it is possible to combine the HDS24 with other Bucher Hydraulics flow-sharing valves for higher flows such as the HDS34, LVS12, and LVS18 up ▷

Table 1: Main characteristics

Technical Data:		
Max inlet flow		130 l/min
Max work port A/B flow (13 bar /190 PSI margin)		100 l/min
Supply port P max continuous operating pressure		280 bar
Work port A/B max peak pressure		320 bar
Max internal leakage A/B -> T (at 100 bar / 1430 PSI, 50° C, 23 mm2/s) Lower values on demand	Without port valves With port valves	16 cc/min 20 cc/min
Max contamination level		20 / 18 / 15 - ISO 4406:1999 (NAS 1638 class 9)
Fluid temperature (NBR seals)		-20°C / +80°C
Viscosity operating range	recommended admissible	from 15 to 75 mm^2/s from 12 to 400 mm^2/s
Max number of elements		10
Ambient temperature in operating conditions	With mechanical/hydraulic/ pneumatic controls With electric/ electro-hydraulic devices	from -30 to 60 °C from -30 to 50 °C
Port threads size (A/B):		1/2" BSP, SAE10, M22x1.5 or equivalent
Port threads size (P/T):		3/4" BSP, SAE12, M27x2 or equivalent

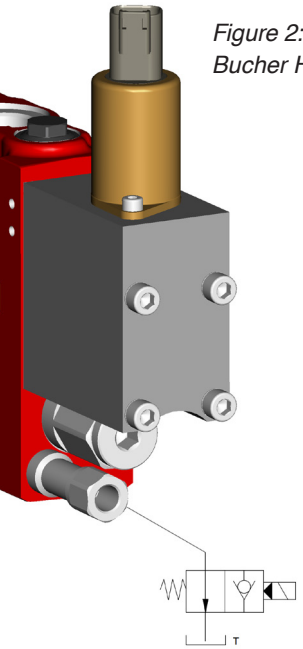

Figure 2: The HDS24 with remote flow cut off (Source: Bucher Hydraulics)

to 250 l/min per section or, by dedicated inlet plate that sets a fixed flow from the variable pump, with open-center valves such as the HDS11 or HDS16.

LS local pressure limitation

The announced option of closing the section compensator through the LS pressure limitation function is now available on the HDS24 flow-sharing valve. The two LS relief valves can be integrated in the section just as on a standard LS pre-compensated valve.

This LS local relief function enables the compensator to close the oil passage to the A or B port when a defined pressure is reached, and independently of the spool position. Compared with a standard port relief valve, this solution has the advantage of closing the oil passage to the outlet ports. The energy losses are less because, with the local compensator in the closed position, the flow through the section is almost zero. With secondary-port relief valves, the full section flow goes to tank at the valve setting, with high heat generation and waste of energy. A further advantage with this solution is that the oil, which is not going to the tank, is then available for other sections, giving faster parallel movements. When the LS relief valve is replaced by an on/off solenoid valve, we can close the compensator with an electrical signal. By connecting the LS port to tank, the local compensator is pushed to the closed position and flow cannot pass to port A or B even if the spool is piloted. This is a feature used in applications where an extra safety function, integrated in the main valve to stop actuator movements, is needed.

CAN network and stepper motor

The Tier IV engines and the forthcoming newer engine generations are forcing all OEMs (original equipment manufacturers) to use more and more electronics on their machines. As a result, the CAN system has been used not just on large construction machines but also more and more on medium and small-sized machines. For this reason and in order to have an easy "plug and play" solution, the CAN-based J1939 higher-layer protocol, is already available on the HDS24 stepper motor version. The stepper motor itself, through the CAN network, can receive and send data such as error information and spool position (from the number of the motor steps) from/to the other electrical devices. The on-board electronics also have the advantage of being able to process information internally and to work in closed loop, sending only the main important information to the other electronic devices, without exceeding the CAN information capacity.

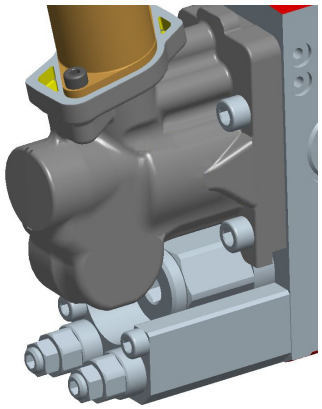

Figure 3: The HDS24 with integrated LS local pressure limitation (Source: Bucher Hydraulics)

On a standard system where the main valve is piloted with PWM (pulse-width modulation), an interface module to translate data from the CAN network to an electrical power signal is needed. Thus, the host controller has to manage the pilot signal to the valve, read the feedback information from sensors, and make the comparison between the two signals, and check if the target position has been reached. All these information exchanges and calculations require CPU (central processing unit) and CAN time, with a risk of overloading the system.

Using the CAN-connectible on-board electronics of the HDS24, many of the necessary items of information are managed internally on the electronic card mounted on each section, and the data items transmitted to the CAN are the only information needed by the system. In this configuration, the data exchanged is brought down to the minimum, and the risk of overloading the CAN network is very limited. ◀

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